C4I Applications Utilizing Embedded Simulations

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DII COE

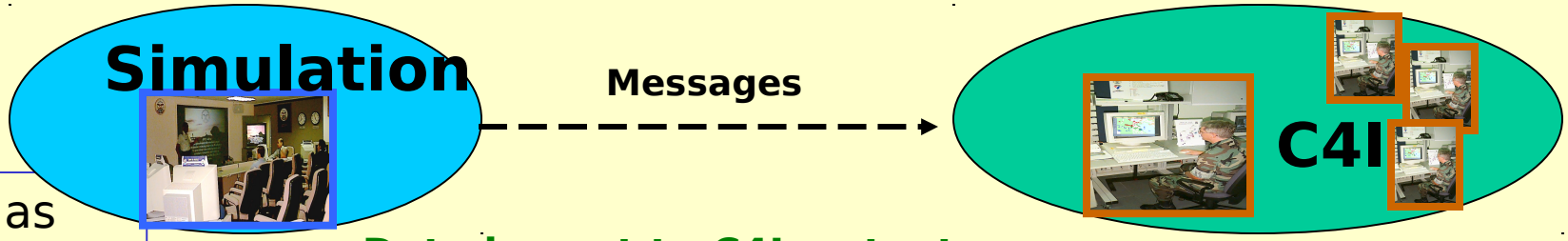
- Architecture you MUST use (or interoperate with and be accredited by) for operational M&S use.
- Not hospitable to M&S
- Require M&S extensions to the DII COE

Navy MSMO has sponsored development of the DII COE

Embedded Simulation Infrastructure

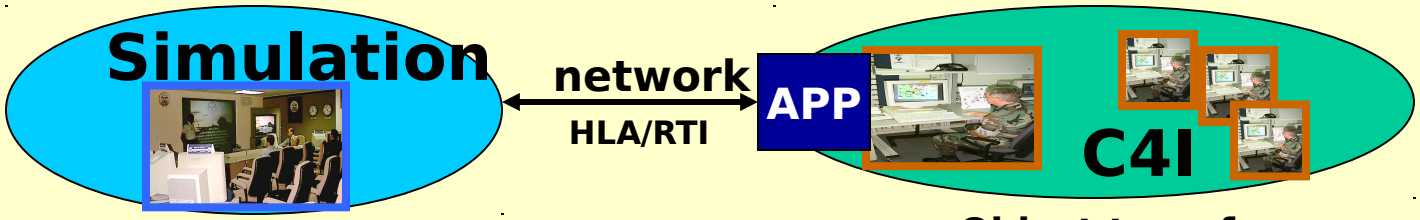
Stages of C4I/Simulation Interoperability

C4I as "Black Box"



Data is sent to C4I as text messages

C4I Application Interoperability



Object data exchanged

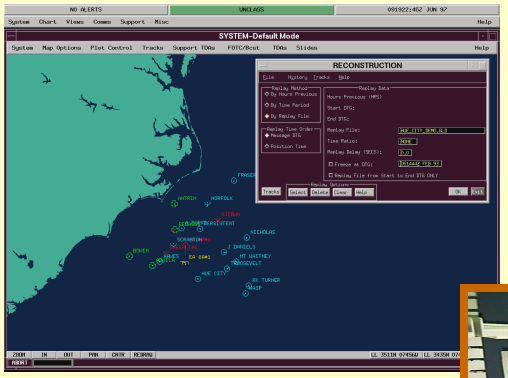
- Object transfer
- Distributed functionality
- Database synchronizati

Simulation in C4I Tactical Application

DII COE C4I

- Object commonality
- Simulation part of COE
- Database Integration
- Tactical Picture Integrati
- Fully portable

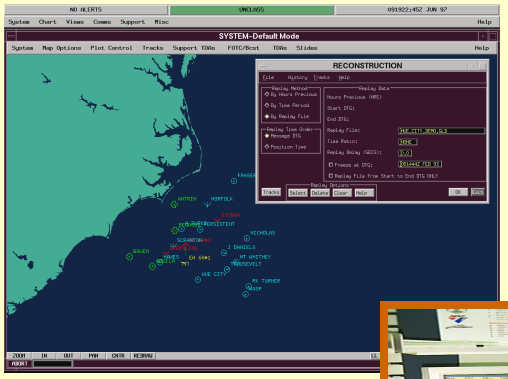
Situational Awareness



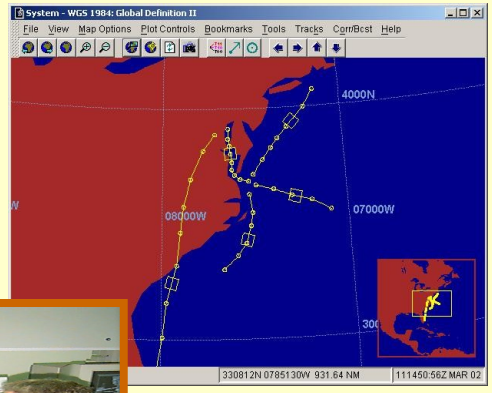
Geographic Data Fusion

- Electronic Map
  - Time/History animation
  - C4I systems fusion
  - Real-Time display
- Geospacial “Drill-Down”
  - Track Data
  - Logistics
  - Intelligence

Situational Assessment



Real-Time COP



SIMCOP

Future Planning view (Plan Domain)

Situational Awareness

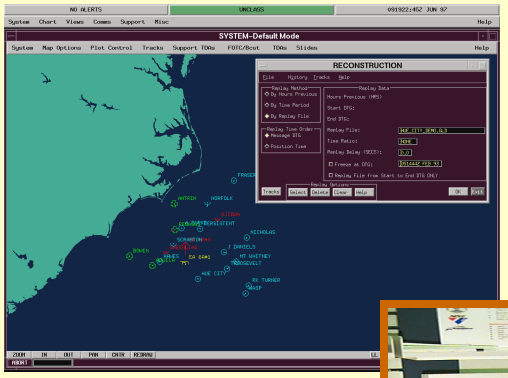
+

Time projection/analysis

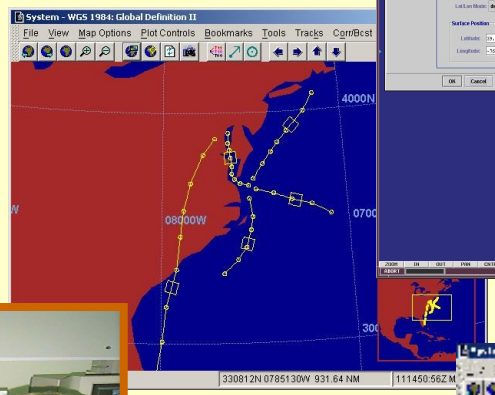
Integrated Planning/Analysis

- Tactical, in-situ assessment/insight
- Time Projection for COA Analysis in SIMCOP view

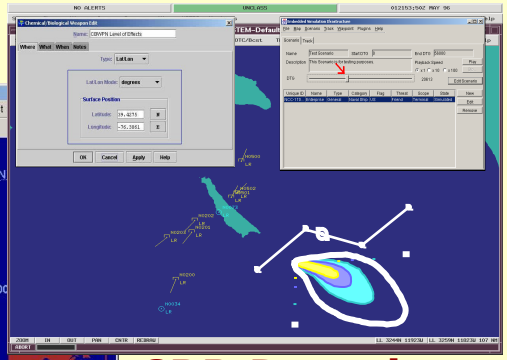
Adaptable C4I Operational Domains



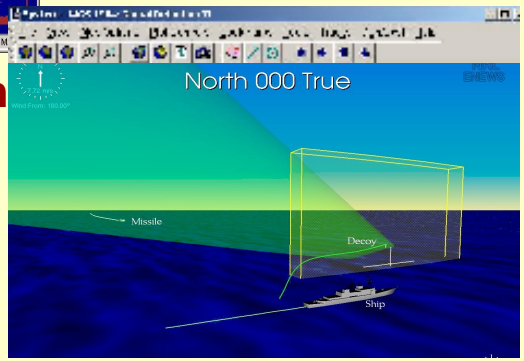
Real Time COP



Plan Domain



CBR Domain

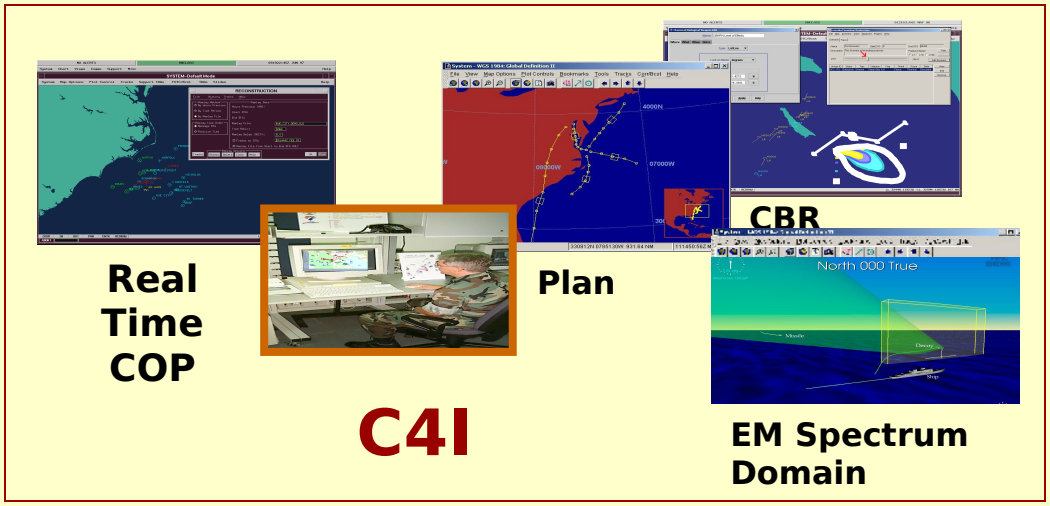


EM Spectrum Domain

- **Situational Awareness**
- **Time projection/analysis**

Geospacial Information in Simulation/C4I TDA Generated “Operational Domains”

Adaptable C4I Operational Domains



Complementary "COPs"

- Overlays (time projected activ
- Inserted objects (CBR "Clouds"
- Other views of battlespace:
  - **EM space**
  - **Acoustic space**
  - **IW space**
  - **Network space**

- **Information/processes beyond human cognition**
- **Geospacial information other than track data**
  - May be multidimensional (2-3D plus time)
  - Displayed in COP as adjunct data/objects overlays
  - Displayed in SIMCOP as alternate views in
    - Time base
    - Visualization (3-D etc.)
    - Function (control/analysis/planning)

Tactical C4I Decision Support

Tactical vice Deliberative Planning process

Situational Assessment

- Simulation/C4I TDA used to evaluate Course of Action
  - Requires Scenario Generation tools and capture of real world C4I picture/ integration into C4I COP
  - Need to create electronic “plans”/scenarios for evaluation by simulation TDA and distribution to other users
  - Timeliness of results critical to tactical relevance
- Simulation/C4I TDA used to produce C4I Adaptable Operational Domains of information for analysis
- Simulation/C4I TDA used to show effects of current operations and planning options

Embedded Simulation Infrastructure (ESI)

Program Objectives

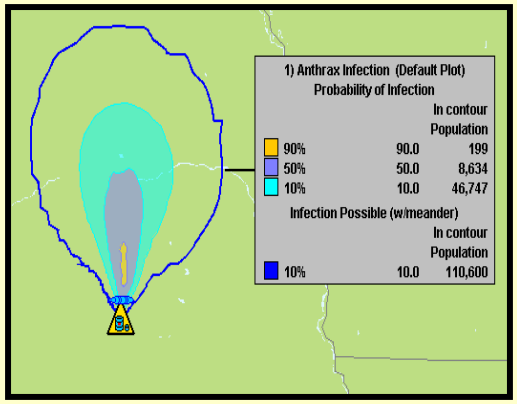
- Create a Modeling & Simulation Environment DII COE for development of simulation based Tactical Mission Applications*.
  - Link simulated data to DII COE Services
  - Develop additional DII COE M&S Services
- Develop proof-of-concept C4I Mission Applications
  - Weapons of Mass Destruction Analysis
  - C4I Team Training System (SPAWAR)

*** e.g., Tactical Decision Aids, COA Analysis, Situation Assessment, Mission Planning, etc.**

WMDA Mission Application in GCCS/M

Provide on-site situational awareness of nuclear, biological, and chemical **(NBC)** weapon information and processes that are beyond human cognition in “raw” state.

Predict and visualize the dispersal and hazardous effects associated with potential or occurring NBC attacks or from attacks on NBC facilities.



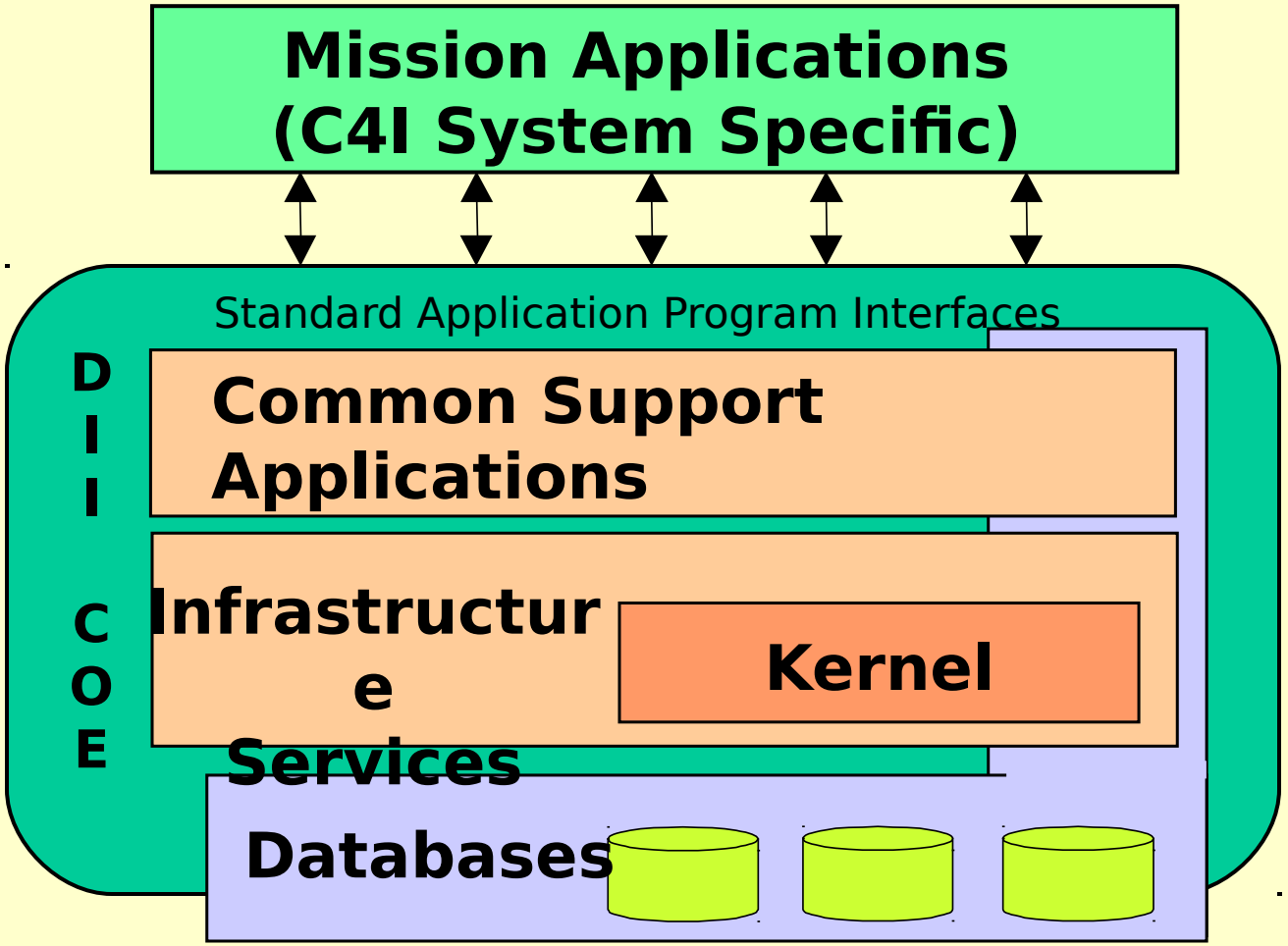
Operational Use

- **Situation Assessment** – (Time Immediate)
  - Tactical, in-situ assessment of WMD effects & vulnerabilities.
  - Time Projection for COA Analysis & After Action Reviews
- **Planning Analysis** - WMD effects & force protection. (Deliberate)
  - Force disposition planning.
  - Strike planning for WMD secondary effects.

Functional Requirements

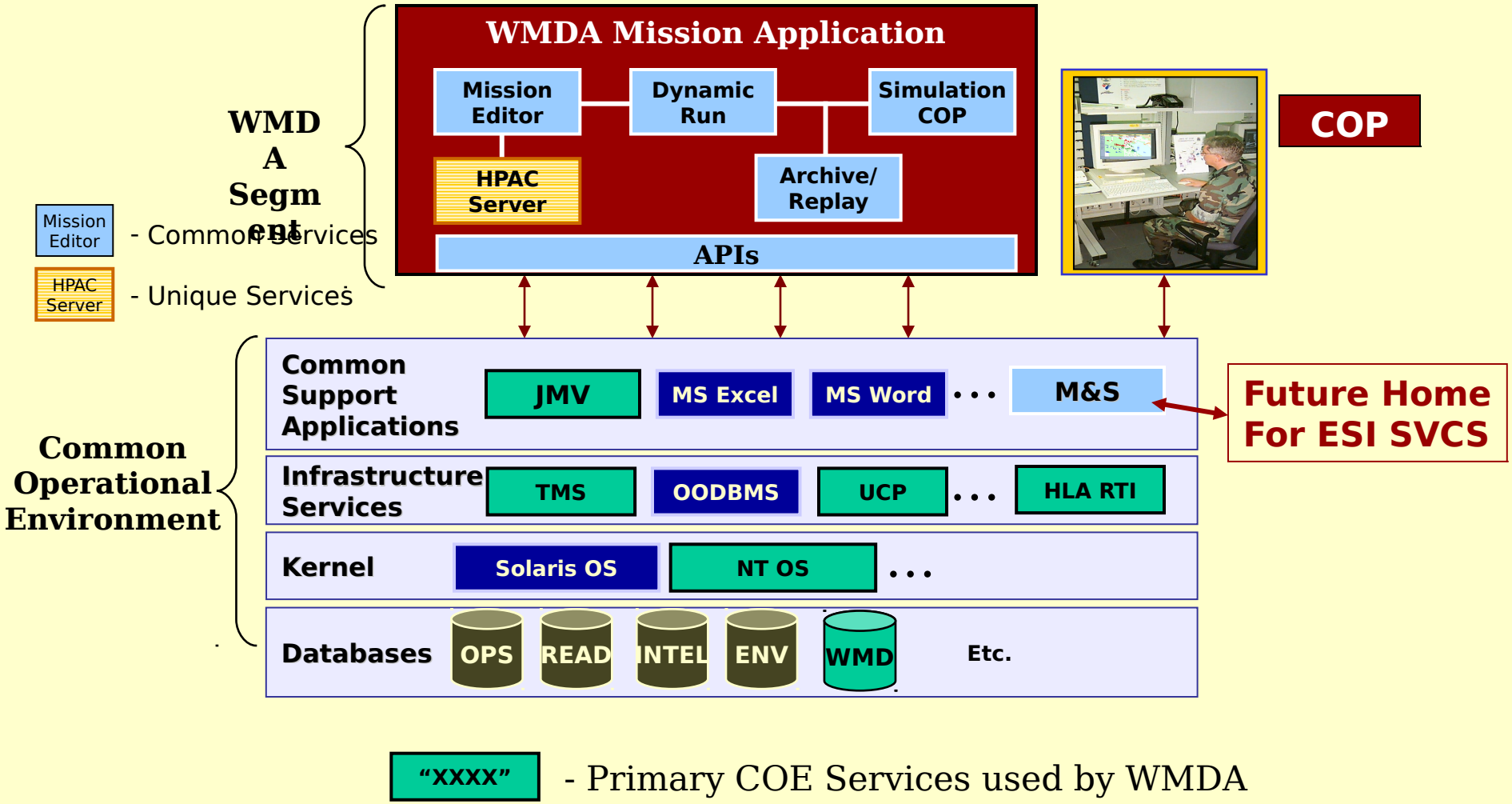
- **Estimate contamination, propagation and lethality.** (Concentration contours & casualties).
- **Operate with C4I tactical databases.**
  - Timeliness - “live” information.
  - Using query/access methods used for real world ops.
- **NBC information layered into operational picture.**
  - Provide geo-spatial display & time projections for fallout/ contamination clouds vis-a-vis force movements and populations.
- **Ability to interact with mission plans / operational scenarios / other C4I Mission Applications.**

Simplified DII COE / C4I Architecture

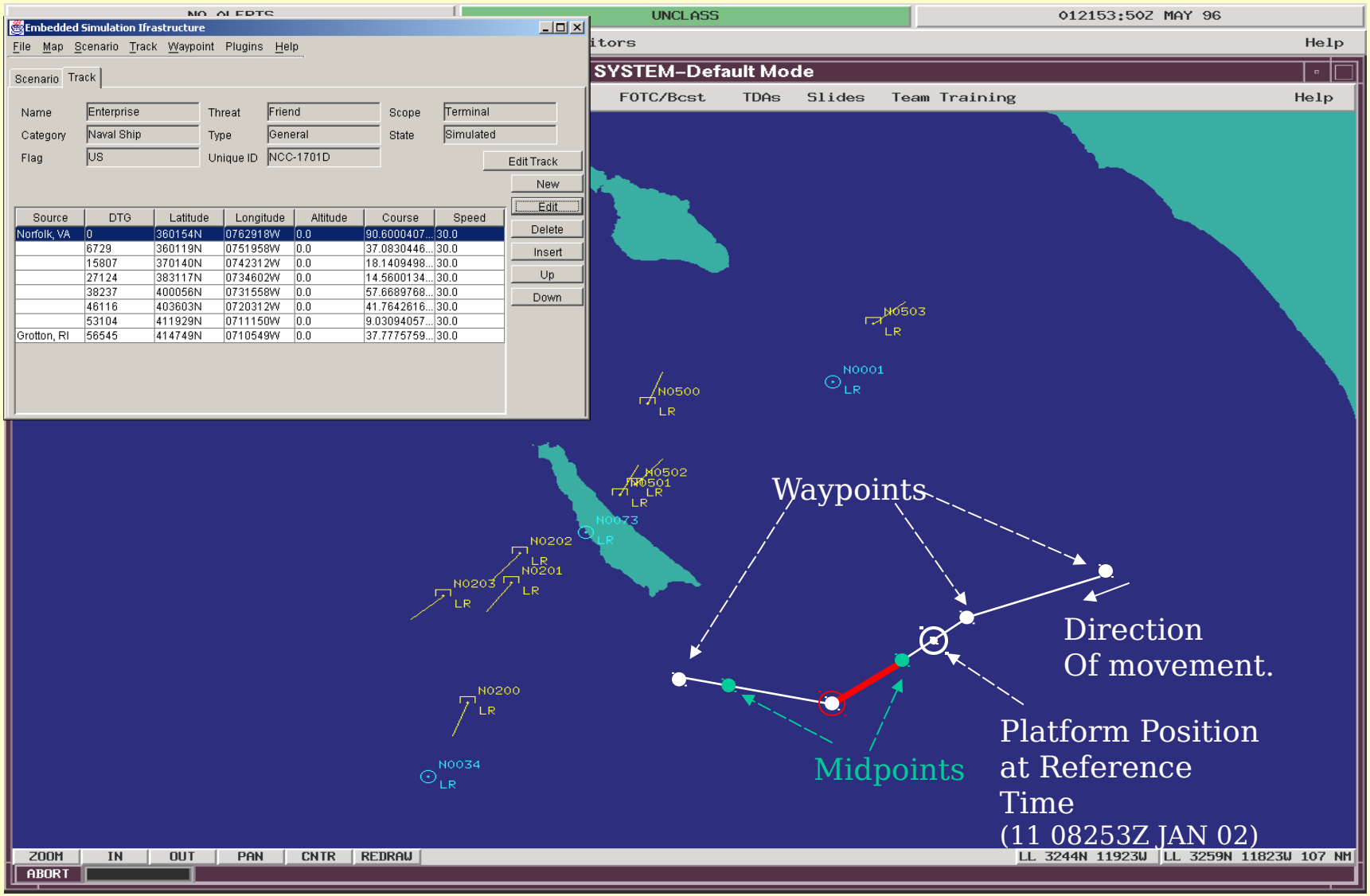


WMDA Mission Application

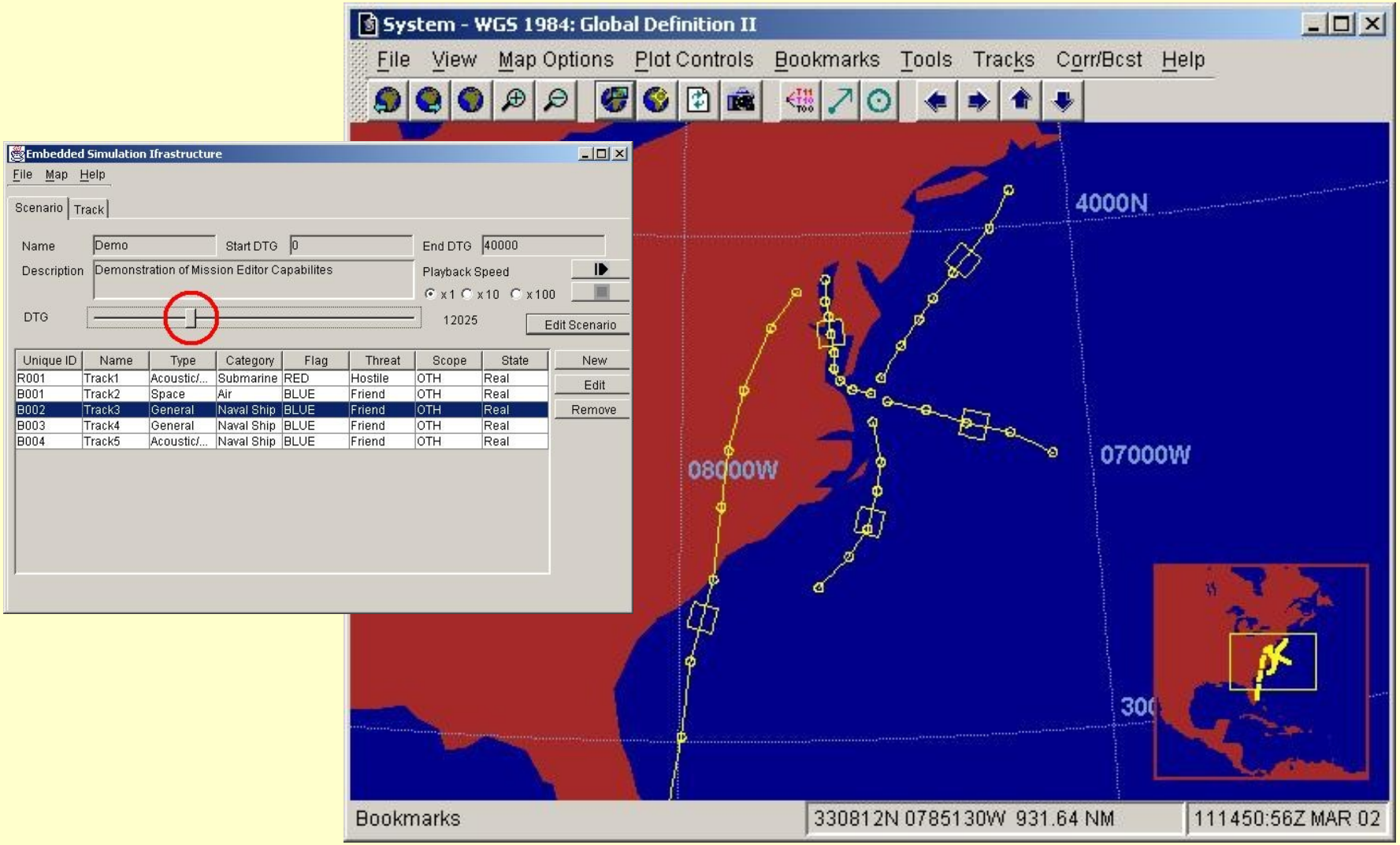
Segment/COE Architecture



Scenario Generation

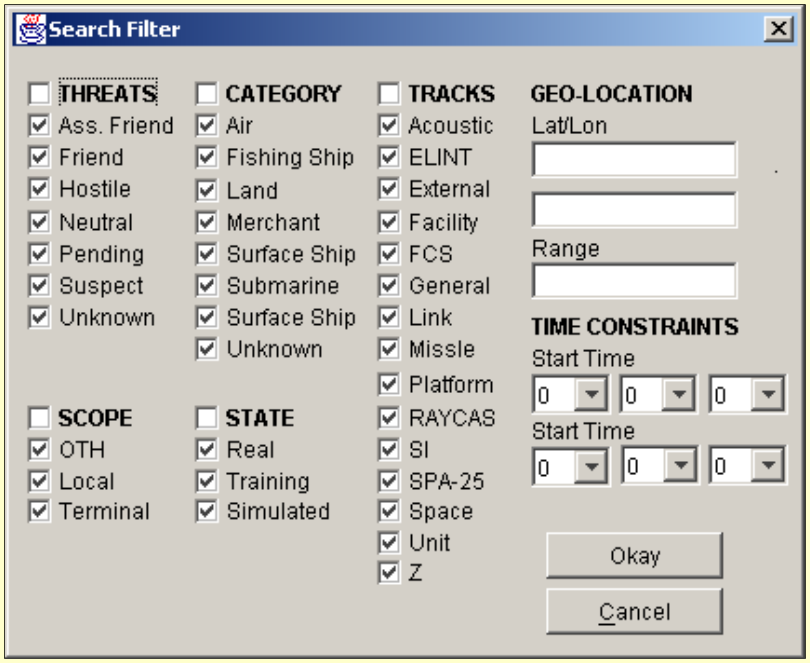


Scenario Editing



COP Capture

M&S Service

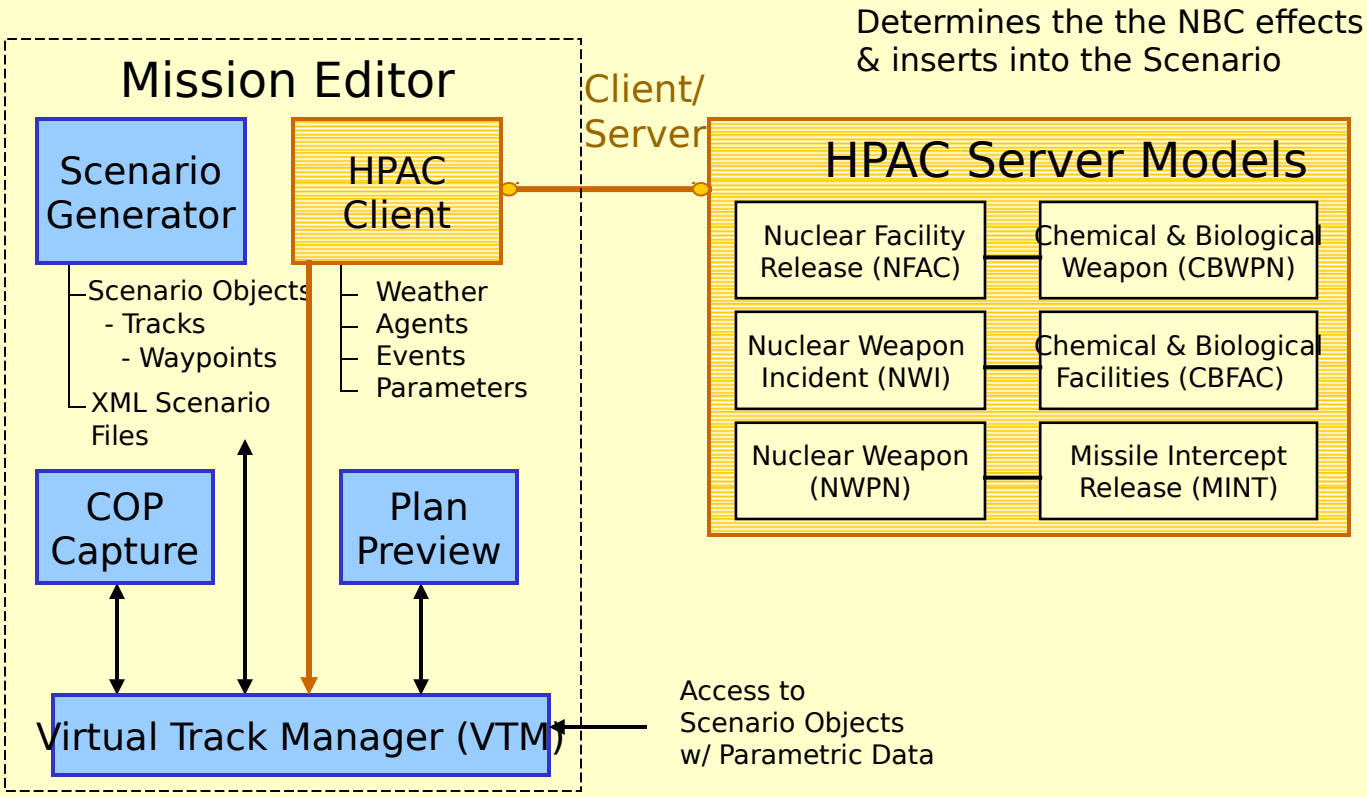


Purpose: capture real world tracks and provide them to an application for initialization & time projections.

- Select Tracks of Interest (Forces, Platforms, Track Types, etc).
- Select geographic location (lat/long and circumference area).
- Extract data from TMS.
- Set DTG.
- Provide to an Application as:
  - Simulated Tracks Objects (TMS-4 objects).
  - Message Objects (OTH Gold, RRR, DIS).

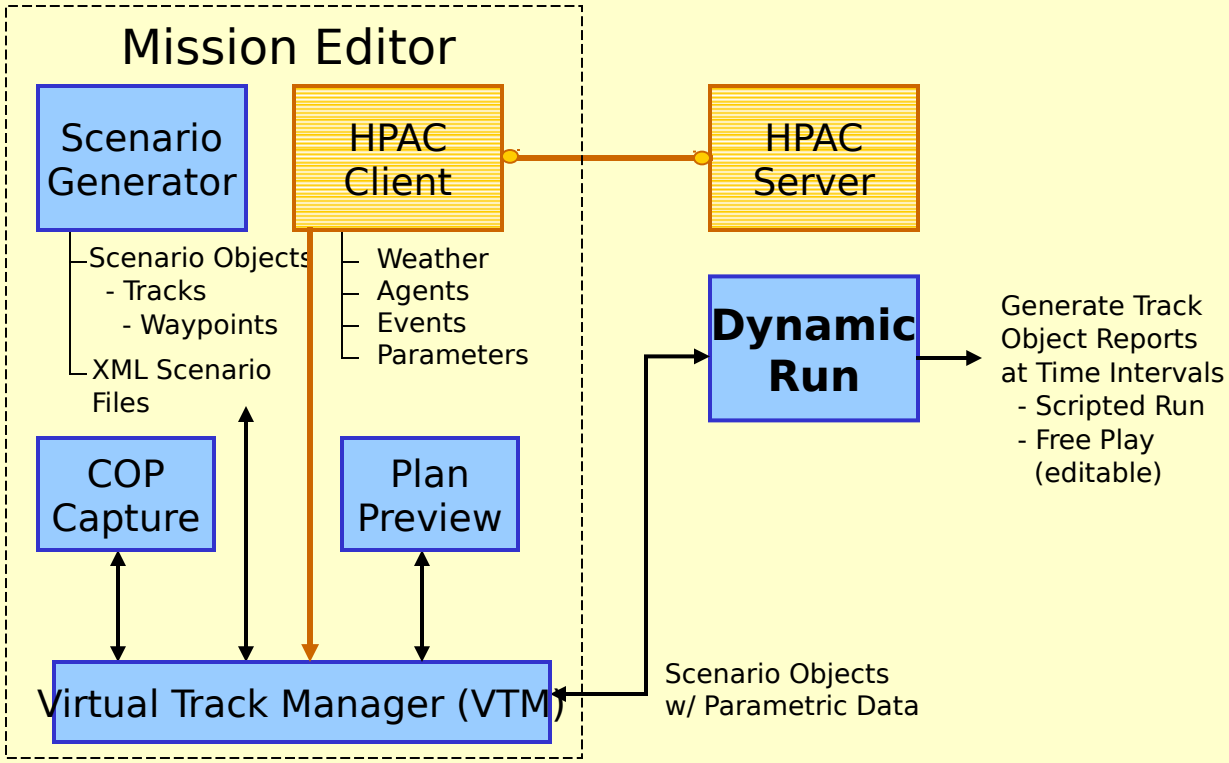
WMDA Mission Editor & HPAC Server

Run the Hazard Assessment Model



WMDA Mission Application

Generate the Plan Dynamics



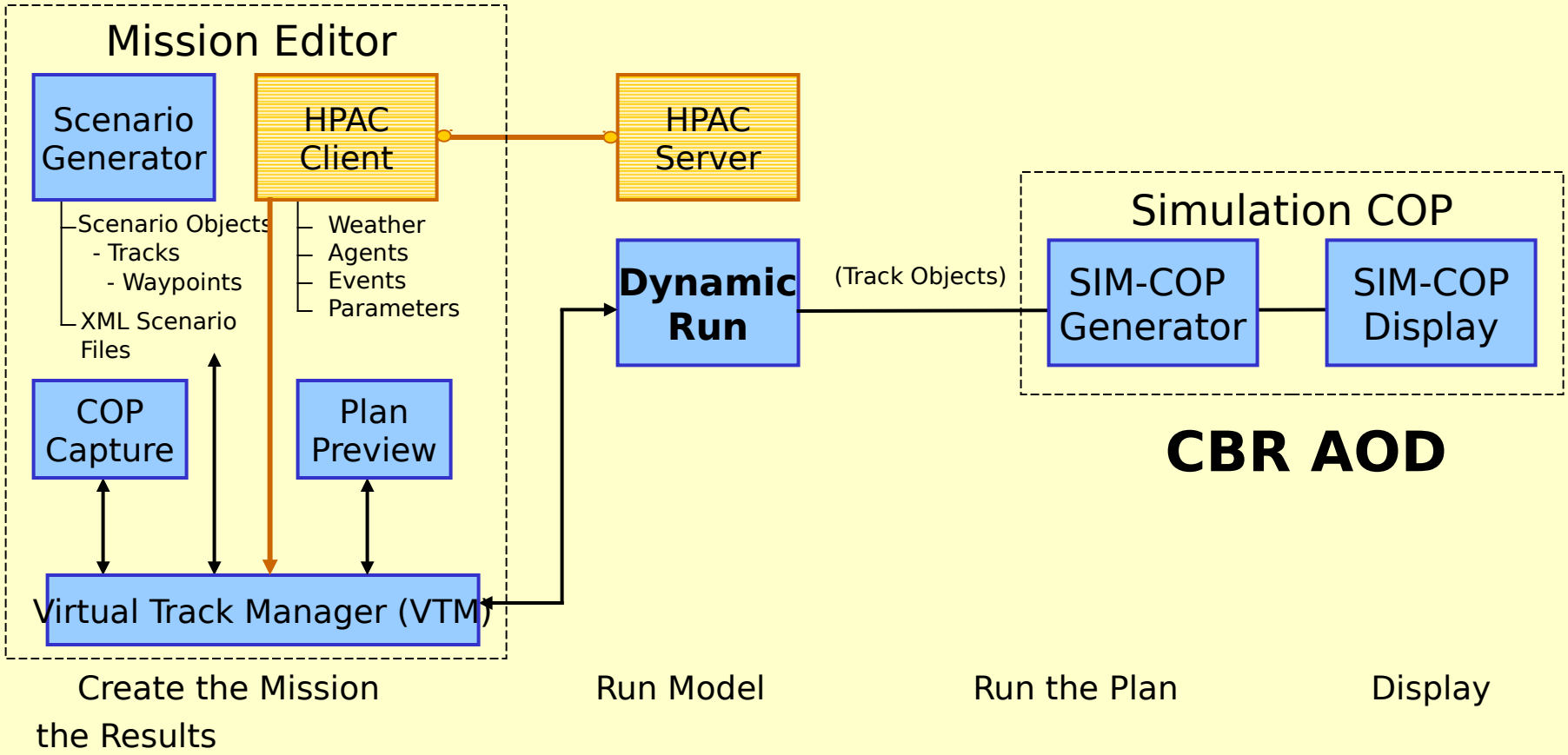
Create the Mission Plan

Run Model

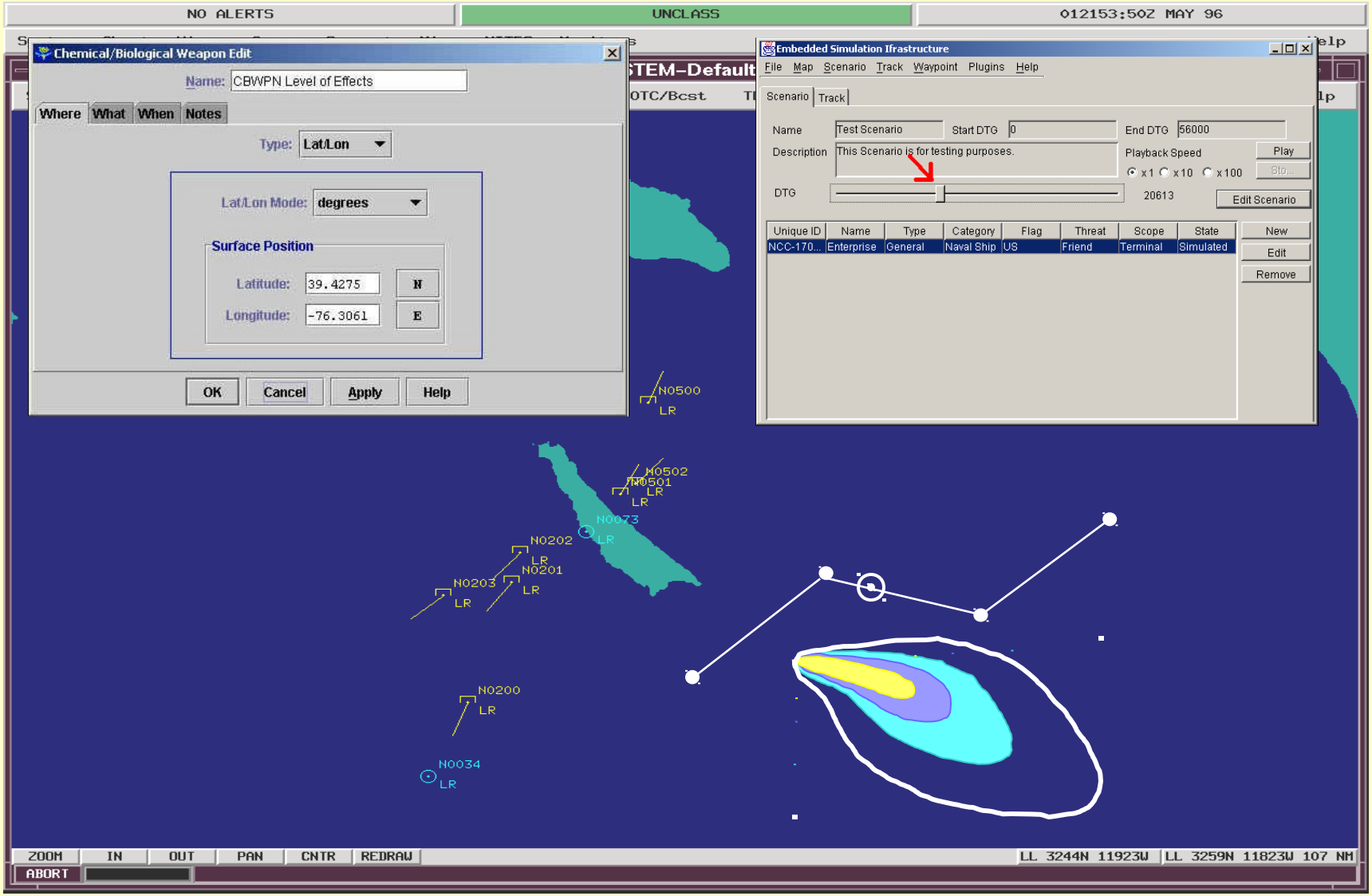
Run the

WMDA Mission Application

Display the Resulting Analysis



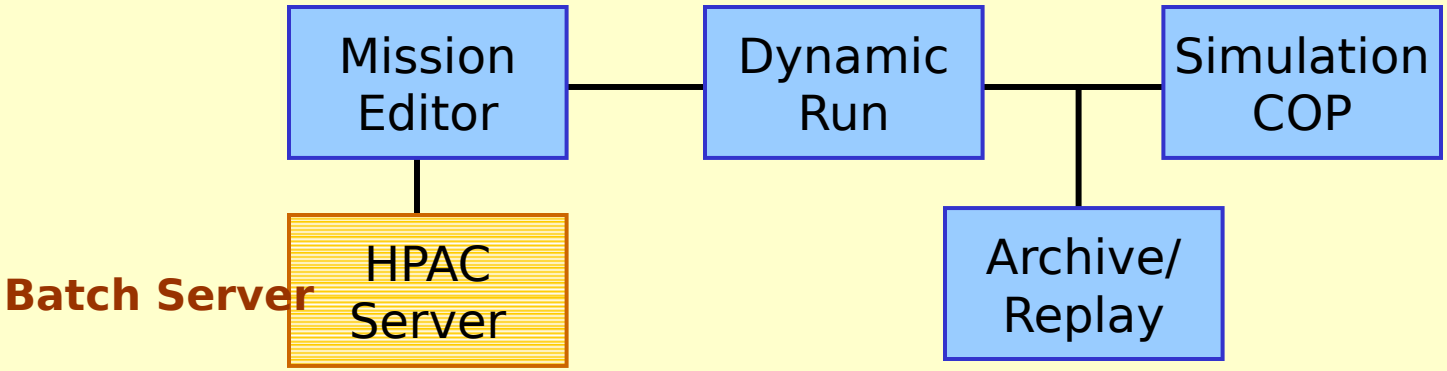
WMDA Mission Application



ESI Services Reuse Examples

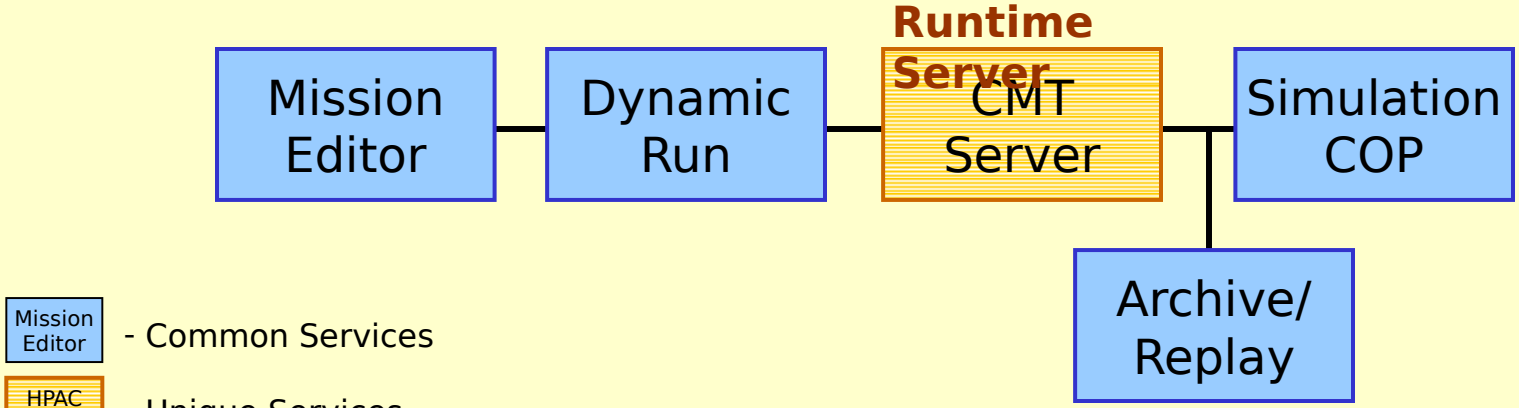
- Weapons of Mass Destruction Analysis (WMDA)
- C4I Team Training System (CTTS)

WMDA & CTTS Top Level Block Diagrams



Weapons of Mass Destruction Analysis (WMDA)

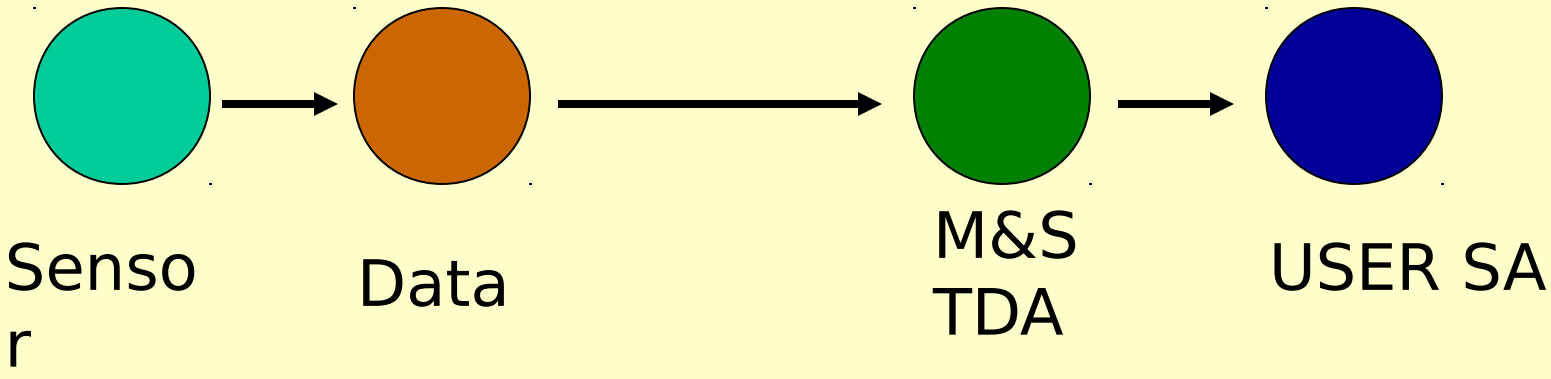
(Planning Mode)



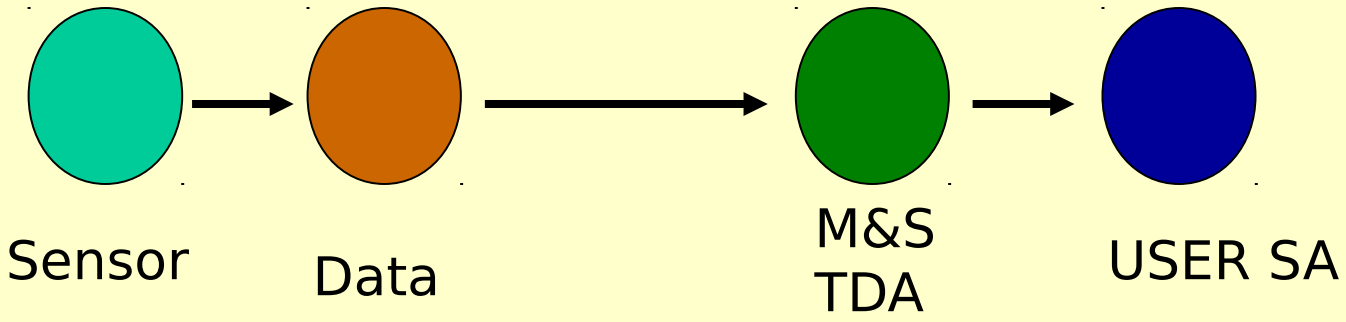
C4I Team Training System (CTTS)

Validity of M&S TDA's

- Non-Extrapolation in model use
  (known Domain/Range and some known data)
- Deterministic models first (C4I *Relevance*)
- VV&A of model itself insufficient
- Requires validation of model as a function of:
  - C4I TDA it is included in
  - Data input
  - SA output to user



Validity of M&S TDA's



1) Uncertainty Analysis:

ds → f(s) → g(f(x)) → r(g(f(x)))

2) Perturbation Analysis:

Ds → Dsa

Validity of M&S C4I TDA's

Areas for Investigation:

- **WHOLE** system (end to end) Validation of model **IN** C4I TDA

- Focus on inputs to system, and outputs to user independent of modeling

- Validate against doctrine, and acceptable **OPERATIONAL** results from:
  SENSOR TO DECISION MAKER

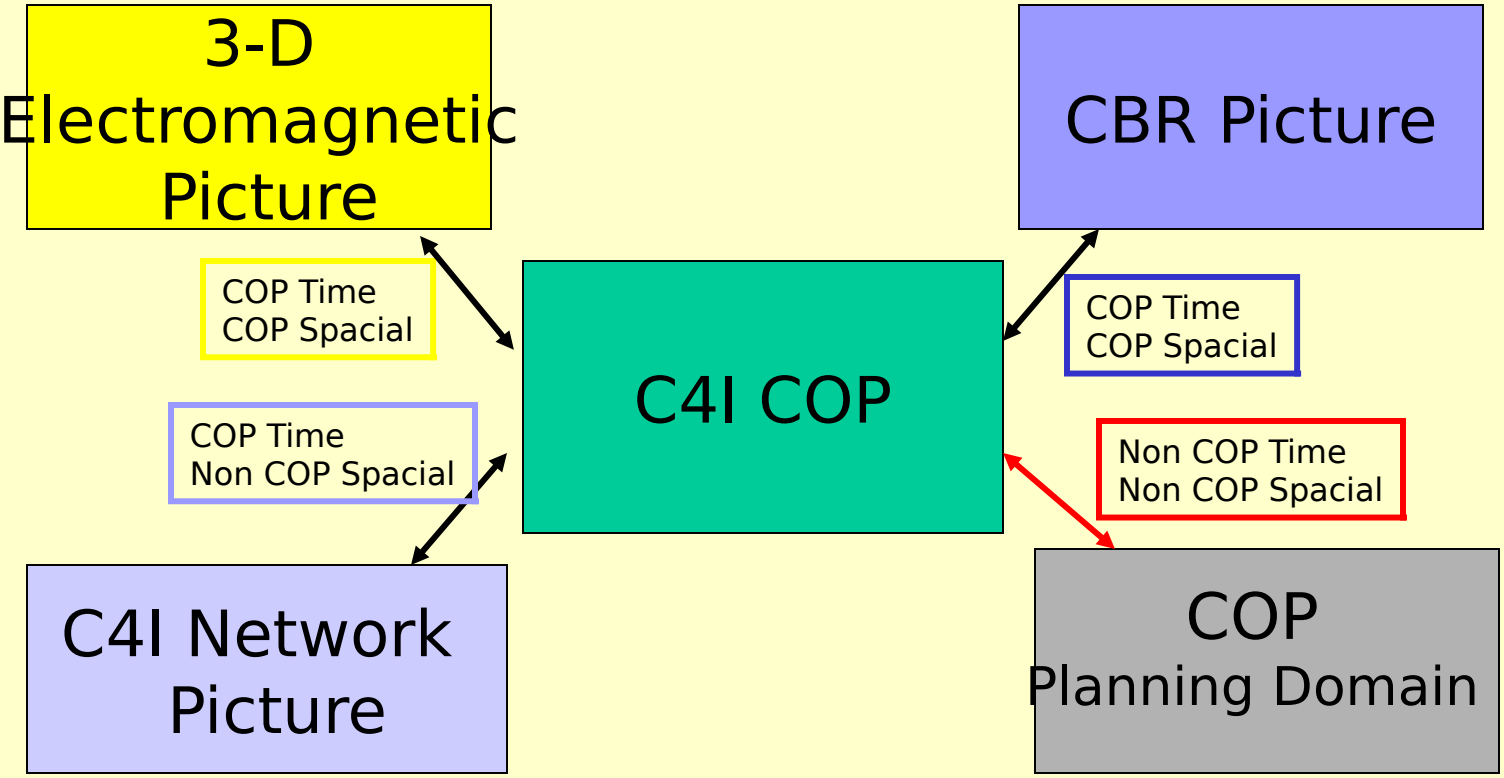
- Possibility of using Statistical Experimental Design methodology

The ESI Program Products

- An established Embedded Simulation Architecture used in C4I Application designs:
  - WMDA Mission Application
  - C4I Team Training System
  - GCCS/GCSS/I3 Embedded (operator level) Training
  - Reconstruction Segment
  - LATR/C4I
- Initial WMDA Mission Application prototype capability planned for FY/CY 02.
- FY-03 project COE M&S Developers Toolkit.

END

Adaptable C4I Operational Domains

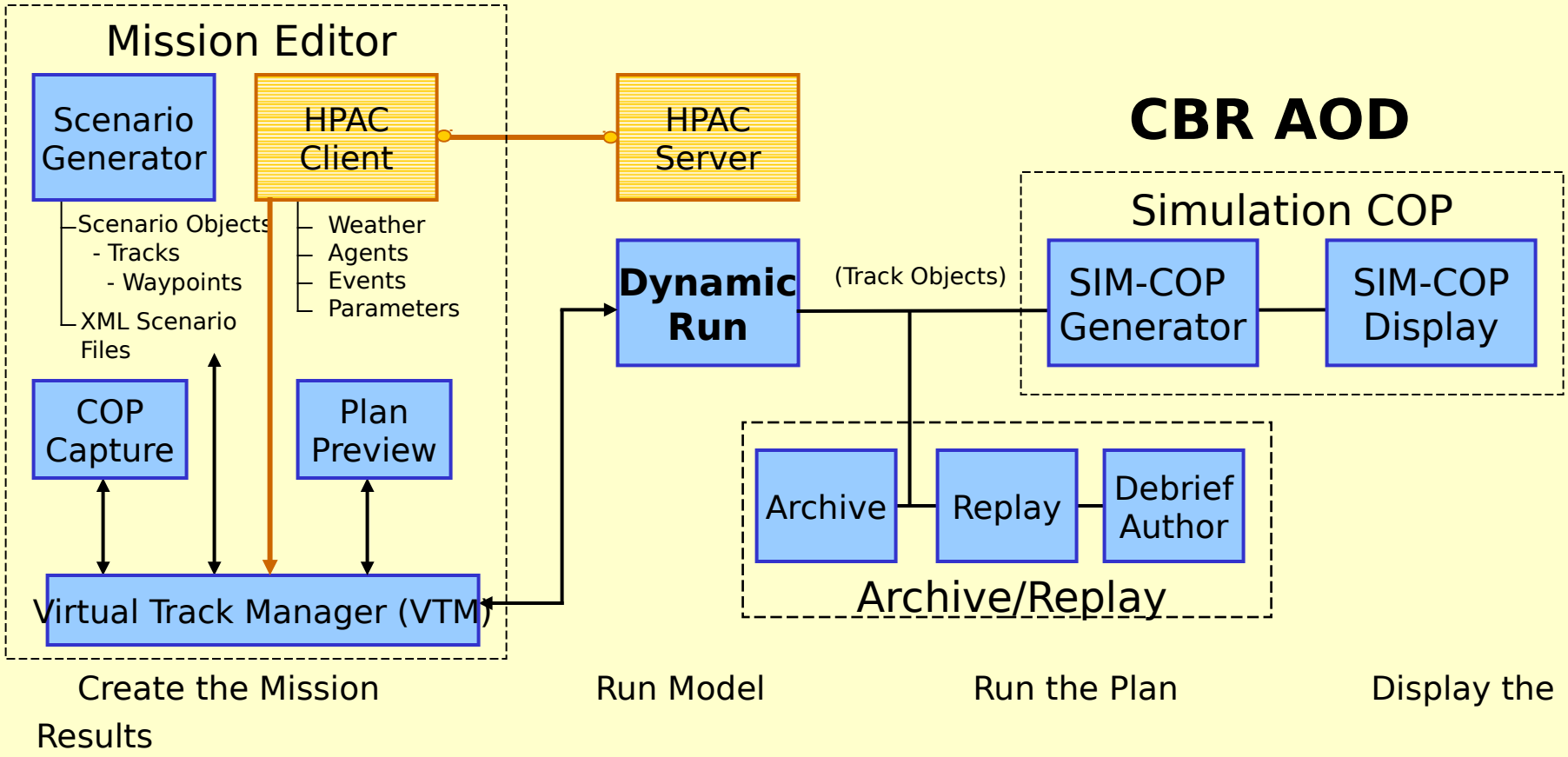


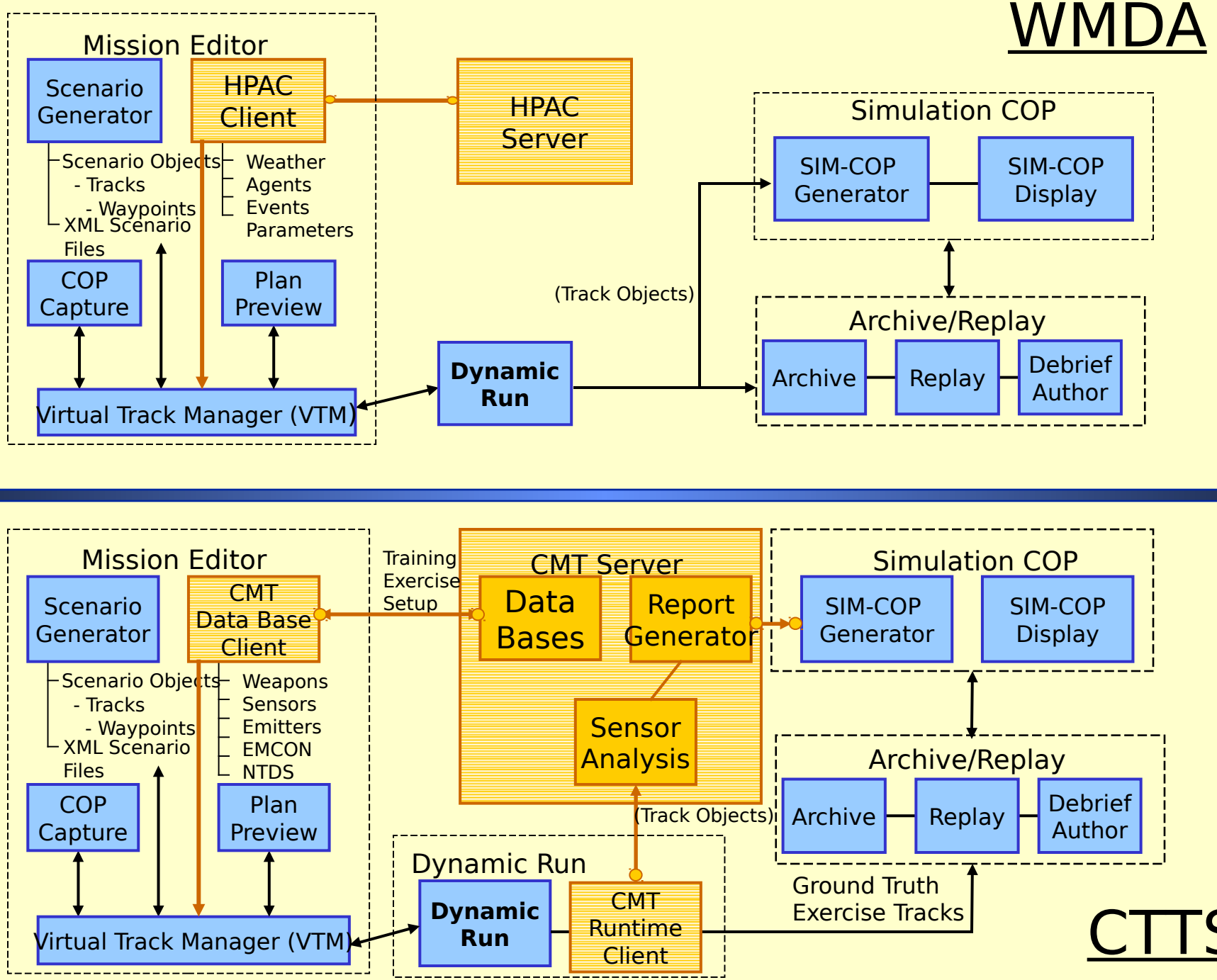
Each visualization of an AOD transitions to/from real-time monitoring mode to the Planning Domain for:

- Situational Assessment (COA Decision Support)
- Deliberative planning

WMDA Mission Application

Archive, Replay & Debrief




WMDA
Mission Editor
Scenario Generator
HPAC Client
HPAC Server
Scenario Objects
- Tracks
- Waypoints
XML Scenario Files
Weather
Agents
Events
Parameters
COP Capture
Plan Preview
Virtual Track Manager (VTM)
Dynamic Run
(Track Objects)
Simulation COP
SIM-COP Generator
SIM-COP Display
Archive/Replay
Archive
Replay
Debrief Author
Mission Editor
Scenario Generator
CMT Data Base Client
Training Exercise Setup
CMT Server
Data Bases
Report Generator
Sensor Analysis
Simulation COP
SIM-COP Generator
SIM-COP Display
Scenario Objects
- Tracks
- Waypoints
XML Scenario Files
Weapons
Sensors
Emitters
EMCON
NTDS
COP Capture
Plan Preview
Archive/Replay
Archive
Replay
Debrief Author
(Track Objects)
Dynamic Run
Dynamic Run
CMT Runtime Client
Ground Truth Exercise Tracks
Virtual Track Manager (VTM)
CTTS

Adaptable C4I Operational Domains

- Information may be:
  - “Layered” onto Operational Picture
    - I3; appended information to 2-D track like objects
  - Require unique geospacial display
    - EM spectrum; 3-D display of all radar and esm activity
  - Both
    - CBR application; 2-D representation of “cloud” in2-D COP, 3-D window showing altitude characteristics of cloud
- Domain viewed “real-time” with traditional COP
    - Separate window with unique characteristics slaved to 2-D COP display
- Domain used “non-real” time to access situation with respect to courses of action and operational plans

Tactical C4I Decision Support

- Common Characteristics:
  - Need for Access to C4I Databases
    - Timeliness- “Live” information
    - Using query/access methods used for real world ops
  - Display results in Operational Picture(s)/Domains
  - Deployability with operating forces
    - Configuration managed with C4I
    - No external databases/systems required
  - Ability to interact with C4I plans/operational scenarios/ other C4I Mission Applications
  - “Seamless” movement between time bases